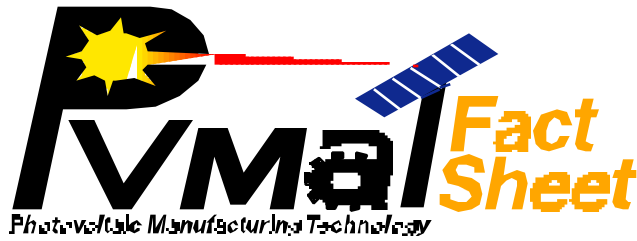


Advanced Modular PV Power Systems

Highlights

- Designed and built a standardized, stand-alone, 200-watt DC PV power system
- Received both UL certification and FM approval for the 200-watt PV system—an industry first
- Designed and built a standardized, stand-alone, 1-kW AC PV/engine-generator hybrid system

Solar Electric Specialties Company participated in the 1995 solicitation of PVMaT—a cost-shared partnership between the U.S. Department of Energy and the nation's PV industry to improve the worldwide competitiveness of U.S. commercial PV manufacturing.



Solar Electric Specialties Company

Goal

The goal of this 1995 solicitation PVMaT project is to develop certified, standard stand-alone PV systems, while reducing life-cycle costs to customers. To reach this goal, Solar Electric Specialties (SES) had the following specific objectives:

- design and build a standard 200-W stand-alone DC PV power system
- design and build a standard 1-kW AC PV/engine-generator hybrid system
- seek Underwriters Laboratories (UL) certification of both systems
- have both systems tested for functionality.

Background

Although most companies that make integrated PV systems offer general product lines, most of the systems the companies sell are *customized* to meet specific customer applications. This practice tends to complicate the design, increase system price, confuse the customer, and make the job of the sales engineer more difficult.

There will always be a need for custom designs, but costs will drop and PV marketability will grow if customers are presented with off-the-shelf systems that meet their needs and that are easy to install and use.

Marketability will also increase if systems are certified by UL, Factory Mutual (FM), or Electrical Testing Laboratories (ETL). Although there has been a trend toward certification of PV *components*, up until now, no PV power systems have been certified.

Technical Approach

This PVMaT project marks the first concerted effort toward developing PV systems that are either standardized or certified. Specifically, SES is developing standardized, modular, pre-engineered systems in its two main product lines—the Modular Autonomous PV

Power Supply (MAPPS) and the Photogenset, a PV-generator hybrid system.

The MAPPS is a small, stand-alone, low-voltage DC power supply that consists of PV modules, a mount, a charge controller, and batteries. These systems range from a single, small module unit to units with several large modules. The output power of the systems ranges from 20 watts to about 300–400 watts. The system voltages are 12, 24, and 48 volts. The systems may also include an optional, small, DC-to-AC inverter for 120 V AC output.



The MAPPS 200-W DC system is the first complete PV power system to be listed by UL and FM.

The Photogenset is a mid-sized, stand-alone, AC power supply with engine generator for load and battery-charging backup. It consists of PV modules, a mounting structure, charge controller, batteries, DC-to-AC inverter, an engine generator, and a container. These systems range from under 1 kW to about 10 kW.

The technical and cost advantages of developing a standardized, certified line of systems are: 1) shorter production lead times, 2) higher overall quality and system reliability, 3) decreased management and engineering time, 4) lower overhead and inventory costs, and 5) lower installation labor and material costs.

There are also marketing advantages. The systems can be specified and described more easily by sales engineers, and customers can more easily assess options and choose systems. Plus, there will be greater customer acceptance of the PV solution and greater confidence among lending institutions.

Results

This project called for developing a 200-W MAPPS and a 1-kW Photogenset as the first prototypes for their respective product lines and for certifying the prototypes and the product lines. The project also called for testing the prototypes to verify their performance and reliability and to develop performance specifications.

MAPPS

SES designed and built two prototype 200-W MAPPS units. The design uses only UL-listed or UL-recognized components. As part of the design, SES developed a new enclosure for the batteries and control assembly. This enclosure costs less than the previous design, uses the internal space better, and provides a separate compartment for the control assembly.

SES obtained UL listing not only for the 200-W MAPPS, but also for a complete family of MAPPS ranging from 10 to 300 W and in 12- and 24-V options. UL performed a rain spray test on the battery enclosure to certify it as meeting the 3R outdoor enclosure rating. UL also tested the control electronics and evaluated all other components.

Following UL's evaluation, a MAPPS unit was modified for FM requirements and submitted for assessment. On completion of the evaluation and a follow-up plant inspection, FM gave approval for a line of MAPPS for use in hazardous locations where incendiary gases are present. Such approval is especially important for industrial and commercial applications, such as oil and gas customers. With this approval, SES became

the first company in the solar electric industry to obtain both FM approval and UL certification.

The second 200-W MAPPS prototype unit was sent to NREL for functionality testing at its Outdoor Test Facility. The unit performed well under load. However, installation and testing identified several minor problems with the mechanical design of the unit and with the installation manual. These problems were corrected in subsequent units.

SES also investigated developing a new microprocessor-based controller for small systems. It will be used as an option when greater control flexibility or remote monitoring are needed. This controller was developed outside this PVMaT project.

Photogenset

SES designed and built a prototype 1-kW Photogenset and performed shakedown testing prior to delivering the unit to Sandia and NREL for functionality testing.

The design incorporates a multi-platform lay-out. The Photogenset can be provided with either a skid-mounted enclosure or in a trailer for mobile applications. SES tried to make maximum use of UL-listed components, but could not get a UL-listed generator and accessories or a UL-listed controller with the remote communications capabilities desired.

SES obtained quotes from both UL and ETL to assess the costs and benefits of each laboratory. SES then contracted with UL for a preliminary investigation to more fully assess the problems, the degree of evaluation and testing required, and the cost of the listing. The results indicated: 1) a fairly extensive testing program would be required for the generator system and the controller, 2) there is no guarantee of listing, and 3) the costs between UL and ETL

appear similar. SES concluded that additional component development and maturity are needed before it is possible to list the Photogenset with either UL or ETL.

Company Profile

Since this PVMaT project was completed, SES has been acquired by IDACORP. Before the acquisition, SES was a leading manufacturer of integrated PV power systems and a major wholesale distributor of PV modules and system components. SES specialized in supplying dealer, contractor, and industrial accounts worldwide with reliable, cost-effective, solar electric solutions.

References

National Electrical Code, 1996. NFPA-70. National Fire Protection Association, Quincy, MA.

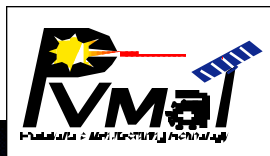
Lambarski, T.; Minyard, G. (February 1997). *Annual Technical Progress Report*, Subcontract ZAF-5-14271-07.

Minyard, G.; Lambarski, T. (August 1997). "Design, Fabrication and Certification of Advanced Modular PV Power Systems." *NREL PV Program FY 1996 Annual Report*. NREL/BK-210-21966.



An SES Photogenset powers a microwave telecommunications site in the Mojave Desert, California.

Shirley Ford/PIX03910



For More Information

Ed Witt, NREL.....303-384-6402

Richard King, DOE.....202-586-1693

Doug Ruby, SNL.....505-844-0317

G. Minyard, SES.....707-459-9496

T. Lambarski, SES.....707-459-9496

www.idacorpinc.com



Printed with a renewable source ink on paper containing at least 50 percent wastepaper, including 20 percent postconsumer waste.

FS-520-24457
DOE/GO-102000-1087
July 2000